★ OCTOBER

Amateur RADIO DIGEST

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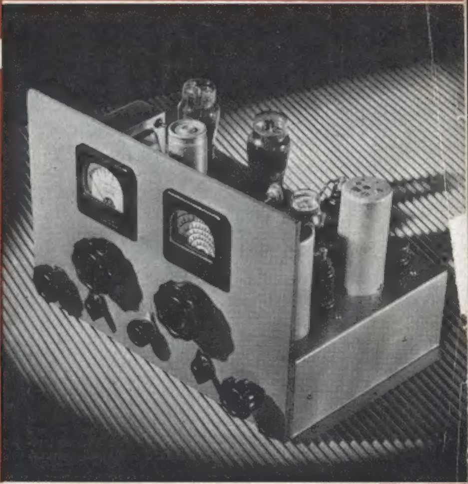

a Simple Super

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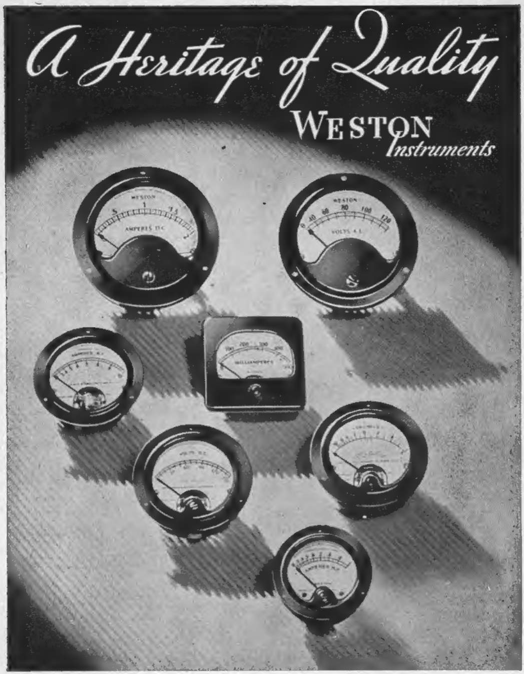

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AMATEUR RADIO

Published in the Interests of Radio Amateurs and
Experimenters throughout Australia.

Vol. 8. No. 8. 1st OCTOBER, 1940

OUR ORGANISATION

Publishers.—
WIRELESS INSTITUTE OF AUSTRALIA
(Victorian Division)
191 Queen Street, Melbourne, C.1.

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H. HEARNE & CO. PTY. LTD.,
285 Latrobe Street, Melbourne, C.1.

Accounts Department.—
LARGE & POWERS,
Chartered Accountants (Aust.),
422 Collins Street, Melbourne.

MSS and Magazine Correspondence should be forwarded to The Editor, "Amateur Radio," Box 2611W, G.P.O., Melbourne.

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EDITORIAL

"Amateur Radio" has definitely improved its appearance as most of our readers will agree, our policy of development is now considerably advanced by the new cover which we think is both modern and attractive. When war commenced, we felt that many of our readers and advertisers would expect us to quietly fade out. We thought it possible, too, on occasions, but at no time has the magazine committee given up hope, that "Amateur Radio" could and would be continued. Working on the policy, that whatever stands still soon slips back, we thought it prudent to change the set up and cover from time to time, with the hope that these advances would increase our circulation. The circulation, which is dependent on enthusiastic support by our readers is likewise the controlling factor in securing the support of our advertisers. Anyone who has ever sold advertising space knows that advertisers as business men are not particularly anxious to support a journal which does not possess a healthy and increasing circulation. We are pleased to say that "Amateur Radio," in its new and improved form, has never been better value from an advertiser's point of view than it is to-day. It is sometimes difficult to impress advertisers that our circulation does not represent a declining market for their products, as the "hams" are off the air. The fact that Amateurs are to be found in all sections of the Radio Industry, in Broadcasting Stations, Design Laboratories, Radio Factories and in Radio Service work of all kinds, indicates that they can and do influence to a very great degree the purchase of radio parts, valves, radio receivers and manufactured radio products.

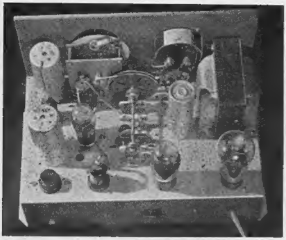
What Amateur does not do some service work, or is not frequently approached by some friend to give his technical advice on the purchase of this or that brand of radio receiver, speaker, pick-up, etc.? We repeat that the Amateur does still influence to a great degree the purchase of thousands of pounds worth of radio equipment annually, although we are at present off the air. Our "ham" readers are asked to read the advertisements in "Amateur Radio," support our advertisers, and when doing so tell them "Amateur Radio" was the medium which was responsible for the sale. Don't forget, continued circulation depends on advertising, without which we cannot go to press, and advertising relies on circulation, and more important still, your support of our advertisers' products.

* *

EDITORIAL ABSTRACT.

Dispelling reports that high power border stations will remain in operation, Ramon Beteta, under secretary of State for Mexico, said recently that licences of all such stations, as a result of the Havana Treaty will expire when the pact becomes operative.

Before leaving Washington, Mr. Beteta declared all preliminary matters relative to the treaty terms had been cleared, and it was his definite understanding that such stations as the high powered border outlaws will stop operating as soon as the continental reallocation is effected.



A SIMPLE SUPER

★

By G. M. Trythall, VK3DA
and M. McCartney, VK3KV.

The main excuse for this article is band-switching, it's there and the set is a great performer.

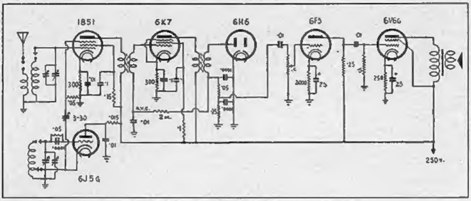
The ideal receiver is often depicted in radio cartoons as one with a multitudinous collection of tubes, oiled-wheel dial control, oceans of gain producing signals that shake the speaker moorings. The cartoons mention nothing about background rackets and signal jamming—we assume, of course, that such things just do not exist. It does not take the practical man long to wake up and realise that just ideals cost money and require skill in construction that is above the average. He is limited to the bank balance and, quite often, in superhet building, experience, and must turn to something that is within his means and ability. Fortunately, to-day, he can make these dream sets come true as far as signal producers are concerned through recent advances in tube design and component efficiency.

After experimenting and playing around with unwieldy 9-10 tube plug in coil Supers for some considerable time, the writers decided it was about time to scrap these ponderous "Signal Snarers" and go in for something modern and smaller.

We believe we have achieved our aim in this, a Simple Super, that with a flick of the Tuning Knob you can cover the band; hear Signals swishing in and out, and if 20 is dead, switch up to 40 or down to 10.

The 1851 Mixer combined with the 6.J.5. High C.Osc. is a system which out-performs by far any of the usual arrangements found in conventional Mixer Circuits. The net result of this combination is high sensitivity and a noise level that is conspicuous by its absence ,and any inefficiencies that may be present in coil switching are certainly made up by the sensitivity of the R.F. end of this set.

The rest of the receiver is quite standard, one I.F. stage is used employing permatune iron cored transformers. Air core I.F.'s were originally used with very good results, but the added selectivity and gain obtainable from the iron cored is to be preferred. The second detector is a 6H6, which happened to be the only suitable tube on hand, a 6Q7 or any diode triode would be equally suitable and more economical, eliminating the 6F5 driver. A noise limiter is an intended addition, and the unused section of the 6H6 offers in this case a method of application. The output stage is quite conventional, and if fully driven will supply a good 4 watts.



CONSTRUCTION: The components are assembled on a commercially obtainable chassis 14 x 8½ x 3½. The lay out is quite visible in the photographs. The tuning control is fashioned on the Hallicrafters S.X.16 and is a delight to operate, and a refinement well worth while. The mere flick of a finger sends the control spinning across the bands which makes for perfect ease in tuning. The reduction gearing is enclosed between two ⅛ in. brass plates 4 x 3½. The gear wheel which carries the tuning knob and flywheel is ⅝ in. diam; this drive meshes with a 4 in. cog, which carries the spiral tuning dial at front and ⅝ in. pulley at rear end which in turn cord drives a 3 in. pulley on the condenser shaft. The result of this mechanism is an inertia control equal to the most expensive American communication receivers.

The controls on front panel from left to right are: H.T. Switch, Band Setter, Band Switch, Mixer Grid Trimmer, and Audio V.C. A large knob is used on the Meter Zero adjustment to balance up with the tuning control.

The bandswitch is a 2 bank 5 position unit, each bank switches 2 circuits.

On each bank, the grid of the mixer and one leg of the aerial winding is switched.

On second bank, Osc. Grid and cathode tap are switched and all other points are earthed.

It is advisable to get one set of coils going before proceeding to wire in next set and although these coils were home wound, commercially wound coils would suit.

In our case it seemed unnecessary to orientate the coils at right angles to each other.

OPERATION: It is advisable to measure the injector grid current of the mixer on each set of coils. To do this insert an 0-1 m/a meter between cold end of injector grid resistor and earth; the reading should be .15 m/a on all bands, adjustments being made in all cases on high frequency end of band. Finally a definite peak will be found when adjusting Osc. coupling condenser, this adjustment should be made on the H.F. coils.

Regarding bandspread.—On this particular set there is approximately 400 deg., this can be lessened by reducing the number of lanes on the spiral dial if so desired.

Reference to the photograph on the front cover will clear up any doubtful points regarding layout.

We feel, in conclusion, that the saying "U've got something there!" as expressed by several amateurs, amply sums up the fine performance of this simple Super.

Problems of H. F. Design

by

O. J. RUSSELL.

+ +

The higher frequencies are becoming of increasing importance and the design of equipment presents a problem very different to that of normal short-wave design. While it has become more usual to extend the range of receivers down to 10 metres, it is sometimes apparent that compromises have been effected, and the extreme high frequency performance is inferior to the rest of the short-wave performance. The designer must nowadays be prepared to consider the prospect of operation down to 5 metres and lower.

Wave Range

The problem of the wide range receiver operating over a wide wave range extending down to the lowest wavelengths, is extremely difficult, as it is almost impossible to avoid having to make compromises of some kind or the other, with consequent lowering of performances on some wavebands. In general it is the highest frequency band which suffers, and because of the inherent difficulty of providing high-frequency gain at these frequencies, the specialised high-frequency receiver has been evolved.

In addition, to avoid the complications of multiband operation, there are also designs for some specific single waveband. In the case of single-waveband receivers for ultra-high frequencies, the designer can adopt measures impracticable for multi-waveband receivers, and ensure maximum efficiency for the selected wave range.

A. discussion of the extent to which a designer may compromise between an ideal design, and a practical design is bound up with so many factors that the question can only be decided by those concerned. The problem is naturally complicated by economic factors, and other questions outside the scope of strict radio theory and practice. However, it is of interest to examine the more strictly technical aspects of the problem of efficient operation upon the higher frequencies.

We may set the limit of normal short-wave operation as being in the neighbourhood of 20 metres (14 megacycles). At higher frequencies, the specific factors operating to limit efficient working are already becoming serious. The most serious factor is the effect of finite transit time of electrons in the valve. The lag, due to the time taken for the electrons emitted by the cathode to reach the anode. represents a loss, which may be expressed as a resistance shunted across the grid cathode input circuit; it makes itself felt as a damping of the grid tuned circuit in a high-frequency amplifier.

This input resistance decreases as this increase resistance decreases as the square of the wave-length, and in most high-frequency amplifying valves is of the order of only 5,000 ohms at 5 metres, or less. The valve becomes, in effect, a low resistance shunted across the input circuit, with loss of selectivity and gain. It is possible to build conventional tuned circuits having resonance resistances of much greater value than this, a value of 15,000 ohms or so being easily attainable.

A partial solution of the problem is to tap the grid of the high-frequency amplifier down on the tuned circuit. By so doing the loss in gain, due to tapping down the coil, is more than compensated, by the increased

voltage developed across the tuned circuit, as the damping is removed. Selectivity is correspondingly increased. In practice, no advantage will be derived by tapping more than about half-way down the coil, as the voltage applied to the grid of the valve will fall off rapidly below this, especially as the tuned circuit has a fairly low value of dynamic resistance with normal construction.

Television Receivers.

In television receivers, where even the moderate selectivity of normal tuned circuits would unduly attenuate the enormous sideband width of the vision signal, the damping, due to low input resistance, is no disadvantage. Special valves of very high mutual conductance have accordingly been evolved, in order to obtain appreciable gain with low input resistance values. It is of interest to note that with the normal type of valve construction, increase of mutual conductance is accompanied by decrease of input resistance, so that there is little advantage for normal purposes to be obtained by the use of these very high mutual conductance valves.

Finite Transit Time

The problem of finite transit time effects may be overcome in two ways. The transit time may be reduced by using higher anode voltages, or by reducing the spacing of the electrodes in the valve. Unfortunately the benefit obtained is proportional to the square root of the appropriate change, so far as the frequency of operation is concerned. Thus to obtain equivalent performance upon twice the normal frequency of operation, we should either have to decrease the electrode spacing to a quarter, or increase the anode voltage four times. In general the solution adopted is to decrease the electrode spacings. The acorn valve represents the practical limit, from present-day production viewpoint, of the reduction of electrode spacing. It must be remembered that for any specific frequency, the benefit obtained by either reducing the electrode spacing, or increasing the anode potential is directly proportional to these factors. In some cases it may be an advantage to operate a valve with increased anode potentials, and increased bias in order to improve performance at the limit of operation of some particular receiver.

It is unfortunately still true that most of the difficulties of high-frequency operation are caused by the imperfection of the valve. Losses due to other components are not nearly so serious, or can at any rate be obviated by special measures. The loss in dielectrics for example is not necessarily increased with frequency, and an excellent range of low loss insulating materials of ceramic and synthetic plastic types, is now available. Indeed the use of very low loss materials has reached at times to ludicrous lengths, as when the thin strip of paxolin type of valve holder is replaced by a holder many times thicker of low loss material, the losses of which, due to the added thickness of material, are probably not much less than the older type of holder. In any case the losses in the holder are much less than those in the base of the valve itself. It is only comparatively recently that the valve base has been modernised, and the footless types of valve have resulted in decreased losses in the valve base, and also shortened the length of the internal leads to the electrodes with reduction of the harmful back coupling effects due to the inductance of these leads.

The question of tuned circuits for high-frequency operation is at present in a state of compromise. For normal work, the conventional coil and condenser provides for reasonable values of Q down to 3 metres or so while extremely high values of Q may be obtained by the use of resonant systems of the concentric line type. Such systems may be tuned over a waveband by the use of a variable condenser, and may be operated up to 10 metres. The values of Q obtained are so great, however, that the use of Acorn valves is virtually essential, and it is desirable to tap the Acorn valve grid well down to the concentric line system, if full advantage is to be taken of the high Q values obtained. The chief advantage of such systems is that for a given diameter of the concentric line system, the Q actually increases with frequency, unlike more conventional

tuned circuits. Such concentric line systems are, however, too bulky for other than fairly specialised use.

In regard to conventional tuned circuits, it is of interest to note that at high frequencies the skin effect is accentuated by the phenomenon of the oscillatory current tending to flow only along the portion of the wire that would touch a cylinder enclosing the coil. The consequence of this effect is that the effective loss resistance of the coil is not greatly reduced by using very thick wire. However, if the coil is wound from flat strip rather than wire, the current has a larger effective surface to traverse, and the loss resistance is proportionately reduced.

While the factors militating against efficiency may most fairly be ascribed to the shortcomings of valves, rather than to serious deficiencies in other components, it is possible by circuital arrangements to obviate many of these losses. In particular, the attention given to by-passing, and to the cathode circuit, are of paramount importance.

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NOTES ON THE SUPPRESSION OF IGNITION INTERFERENCE ON FREQUENCIES BETWEEN 40 AND 60 MC.

The following significant information on this subject is taken from the paper "The Ultra-Short-Wave Interference Suppression of the Electrical Ignition System of Motor Vehicles," by W. Scholz and G. Faust, T.F.T., November, 1939, Vol. 28, No. 11, pages 409-414. The usually recommended scheme of screening the whole ignition system is deemed too expensive as a general solution, while the introduction of high-frequency chokes merely serves to displace the interference to lower frequencies. Furthermore, the use of by-pass condensers large enough to be effective for the ultra-high frequencies reduces the efficiency of the engine, since capacitances greater than 100 uufd .are required. As for resistances, while they are effective for suppression of the ignition interference affecting reception on the standard broadcast band, the suppressing action decreases for frequencies above 15 Mc., because the capacitive leakage reactance becomes lower than the ohmic resistance value. An effective solution was found in using the distributed type of resistance rather than concentrated resistance units. This distributed resistance is obtained by making the ignition connecting leads of spirally-wound resistance wire on an insulating core. This lead has a resistance of 5,000 to 10,000 ohms, about 3,000 ohms per foot of special cable. Leads of this type in combination with capacitances of only 10 uufd. and a fixed series resistance of about 2,000 ohms gives effective suppression not only on the ultra-high frequency range 40-60 Mc., but also on the frequencies below 15 Mc., to which the maximum interference was displaced by the inductance of the special spiral-wound resistance lead.

When combined with special spark plugs in which the resistor unit was enclosed, the interference level at a distance of 7 metres was brought down to a field strength so small that it could not be measured, although the field strength with the untreated motor was of the order of 32 millivolts per meter. With ordinary spark plugs the interference field strength was of the order of 13 mv. per metre with conventional suppressor type resistance units. The field strength of the ignition interference at this same distance was only 4.3 millivolts per metre with the special high-resistance lead and 2,000 ohm resistor unit in series in combination with an ordinary type of spark plug.

DISTORTION

by

DOUGLAS N. LINNETT.

Many factors have to be taken into consideration before we pass judgment on distorted radio reproduction. It will usually be found that there is something wrong with the receiver if the rendition is not realistic.

Analysis of distortion and the quality of reproduction soon shows that there is a human element to be considered. The receiver must give a type of rendition that is pleasing to the differing tastes of owners. This element protrudes itself in addition to the technical qualities of the set.

Evidence is not hard to find because many prefer a type of rendition that has the high notes suppressed and the bass notes brought into prominence. Others demand that the speech sounds, such as "S", "Sh," and "Z" are reproduced faithfully to give a clear and sharp effect which is easy to follow.

Neither of these differing tastes present great difficulty to design, but there is still another factor over which the designer has no control. This has a material influence upon the enjoyment to be derived from broadcasting and comes from the acoustical properties of the room in which the set is worked. Such acoustical properties have a definite effect upon quality, and they can only be compensated for by means of some special tone control.

The definition of quality of reproduction, therefore, has many different interpretations, and there are as many conceptions of the ideal as there are people listening to broadcasting.

A great many would not be satisfied with a receiver designed to give theoretically perfect reproduction and placed in an acoustically perfect room. They would want something different because our hearing mechanism is not perfect. This accounts for much of the variation in taste as to the quality of the rendition to be desired.

Even so, there is often more evident distortion to ruin a broadcast programme. This type can be cured. It may be divided into two general classes for the purpose of discussion —frequency distortion and amplitude distortion.

Frequency distortion occurs in the suppression or exaggeration of some particular note or band of frequencies. In its worst form, there may be an entire absence of the bass or treble, or an unpleasant resonance at various points in the frequency range.

Amplitude distortion is quite different because the wave form of the original sound is mutilated. This becomes evident in a choking or blasting of the rendition.

Invariably, the trouble can be traced to a choice of unsuitable components, incorrect use, or perhaps there are incorrect voltages supplied. They can all be traced, even though there are many different causes and still more numerous cures. So it will be worth-while discussing a few, as one or more may be traced and rectified. That will give a considerable improvement in the quality of reproduction.

Frequency distortion is chiefly caused by couplings and speakers.

The most serious offender is the speaker itself.

Economic reasons demand that the radio must be contained completely within a wooden cabinet, so that the baffle, as provided by the front of the cabinet, is not in accordance with the theoretical ideal dimensions for uniform treatment of all frequencies within the audible range.

The inequalities are recognised and the receiver is balanced at one or more points, or a tone control fitted,

so that the degree of equalisation can be made a variable quantity. The tone control is by far the better arrangement, because it allows changes to be effected according to individual requirements.

The baffle itself is any partition separating the sound waves produced by the front of the speaker from those emanating from the rear surface of the cone. The lowest possible note that a speaker can radiate, is roughly one whose quarter wavelength is equal to the distance from the centre of the cone round the baffle to the same point at the rear.

Since the wavelength equals velocity (1100 feet a second) divided by frequency, an example in a 100 cycle note would be a wavelength of 11 feet, and a quarter wavelength would be 2¾ feet. This would be the theoretical size necessary to reproduce fully such a note at the same level as other higher frequencies.

The Baffle, therefore, has to be made smaller than the size demanded by theory. This does not mean, that none of the lower notes can be reproduced, but they will be partially suppressed.

The resultant tone depends solely upon the size of the baffle, and the amount of compensation allowed in the design of the receiver. This allowance also takes into account, the harmonics which are suppressed to some extent, but they give an indication of their presence in the quality of the reproduction.

Amplitude distortion can generally be traced to the incorrect use of valves. This is often due to the wrong voltages coming from the power supply. Another cause, which is often overlooked because we become accustomed to this form of distortion, is due to the valves losing their emitting properties. When the emission falls below the normal value, the cathode is unable to supply the necessary output, and so the tone gets poor. This gradual decrease in tone value is rarely noticed. The difference becomes very apparent however, when new valves are installed.

Incorrect plate and grid voltages are another great source of trouble. Test will quickly remove this cause.

The plate current, or amplified signals, vary with the grid voltages. If the incoming grid swings take place over the wrong portion of the characteristic curve, the amplified signal cannot be a faithful replica of the input. The operating point must be changed accordingly.

This may mean that the positive half swings will be amplified to a greater extent than the negative swings. The result is what has become to be known as harmonic distortion.

The valves have to be correctly biased to get the right operating point. Here is a fruitful cause of trouble because it is very apparent that many receivers are still operated with a careless disregard for grid bias, especially where the old receivers are still in use.

The object of applying this bias to the valve is to obtain the most satisfactory operating point. Unless this is done, the valve can only work inefficiently and mar the quality of reproduction. A characteristic curve will soon show the correct voltage to apply.

Another form of valve distortion comes from the input signals. They are sometimes so large, that the plate current cannot cope with them. Both ends of the signal are lopped off in such a case. This manifests itself in blasting.

The cause of the trouble is found in the fact that the valve used has not an adequate grid acceptance to provide the high value of plate current. The valve must be changed for one which can deal with the input swings, and has an output sufficient to load the final stage without encroaching on the characteristic curvature.

Further distortion is found in detector circuits. The cause is usually an inability to handle very large voltages, especially where grid leak detection is employed.

The amount of direct current in the grid circuit causes the trouble because it is sufficient to overload the valve on strong signals and distortion results. This can be reduced to a minimum in design, although the trouble is less frequently found with the diode which has overcome many of the inherent defects.

Nevertheless, very keen ears are required with the modern radio functioning properly. It is hard to notice any deficiencies or preponderance of

notes throughout the musical range. Distortion only becomes evident when there is something wrong.

The excellence of quality attained is quite natural in the later designs, and there is some defect in the apparatus if it is not being obtained.

Nowadays, transmission and reception have attained a remarkable degree of faithfulness—that is electrically speaking—and it is possible with well-designed equipment for the musician to obtain all that is desired.

H.F. OSCILLATOR IN RECEIVERS

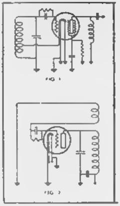
By Dana Bacon in "Q.S.T."

Last month we promised to tell you about a good high frequency oscillator for receivers. You may be surprised to find that we mean to talk about a tuned-plate grid-tickler oscillator which in itself is not new, but since receivers use electron-coupled, or tuned-grid oscillators almost exclusively, the merits of the tuned-plate arrangement are not generally realised and are therefore "news."

As a start, let us take a look at the electron-coupled oscillator shown in Fig. 1. In this, the cathode is at some R.F. potential above ground. As a result, the inter-electrode capacity between cathode and heater (which is grounded) will be across part of the tuned circuit. In addition to causing hum, this causes instability, since a slight shift in the position of the heater will change the oscillator frequency. This can be kept at a minimum by carefully selecting the oscillator tube. It is particularly important to choose a tube having a "folded heater", rather than a "spiral heater." However, when the frequency is high, the only practical cure is to keep the cathode at ground potential. This is most easily accomplished by using either a tuned-plate or tuned-grid oscillator.

It is our exeprience that it is much easier to make a tuned-plate oscillator stable than one of the tuned-grid variety. Most of the theory behind this is rather involved, and since this page is no place for vector analysis, we are not going to go into much detail. There is one point that we can cover easily, however.

In the usual tuned-grid oscillator, the grid current places a heavy load on the tuned circuit, which spoils its Q. At the same time, the tickler coil does not provide enough load impedance for the plate. The net re-



sult is poor frequency stability due to the low Q, and weak oscillation due to impedance mismatch in the plate.

With a tuned-plate, the situation is reversed, with happy results. The tuned circuit provides an excellent load for the plate, of course. At the same time, by adjusting the coupling of the grid tickler a reasonable impedance match can be obtained in the grid circuit, so that ample grid driving power can be obtained without spoiling the Q of the tuned circuit. The circuit for doing this is shown in Fig. 2. Of course there is one disadvantage to this circuit in that it allows DC plate voltage to appear on the condensor stator, but this can be easily avoided by using a blocking condenser.

The plate-tuned oscillator lends itself nicely to electron coupling either by using a separate mixer tube or by a pentode, as in Fig 1. But even without electron coupling we have found that the plate-tuned oscillator is preferable to the types usually found in receivers and possess the same advantages when used in monitors, "rubber crystals," and the like.

A 1-TUBE SIGNAL TRACER

by

CHARLES R. MERCHANT

(From "Radio News," June, 1940)

Try this extremely simple signal-tracer which only uses one tube. While it will not be as good as a multi-tube rig, it works.

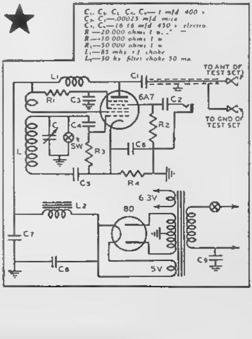
In servicing radios, it is almost a truism that a totally inoperative set is easier to fix than one that "sort of works,"—i.e., is noisy, distorting or weak. It was to make it easier to diagnose these headaches that the following device was constructed, and judging by tests on a considerable number of actual cases it does all that it was intended to do.

It is essentially a signal-tracer which makes it possible to follow a signal, either from a broadcast station or from a modulated test oscillator, from stage to stage and from component to component through a set and find out just where it goes wrong. When that is settled, it is seldom much trouble to figure out what's the matter.

The hook up used is a pentagrid converter circuit whose oscillator section generates frequencies which lie in the regular broadcast band. This is coupled to the antenna and ground of a good set, either a T.R.F. or superheterodyne, but one preferably without A.V.C. A signal fed into the output of the set to be repaired may then be examined anywhere in its career, either as r.f., i.f., or audio, by being fed into the input of the converter circuit through special test cables. If the signal is to be examined in the r.f. stage, the oscillator of the converter is rendered inoperative and the signal is simply amplified and passed on to the test set. If the signal is in the i.f. stages, it is changed back to broadcast frequency in the converter, and if the signal is in the audio stages it is used to modulate the oscillator frequencies in the converter in the same manner as a phonograph oscillator. Thus any defective stage may be located quickly.

One prerequisite in such trouble shooting is that the device used shall not load the circuit. That was one of the great difficulties of the analyzer method of set-checking; the extra capacitances introduced by the analyzer cables were generally sufficient to throw the set into an entirely different frame of mind, and with a sheet of analyzer readings on hand it was often more difficult to figure out what they indicated than it would have been to diagnose the trouble "by ear."

That difficulty is avoided in this instance by using a probe which puts such an infinitesimal load on the circuit that the effect is practically



zero. In fact, if the set under observation is operating strongly at all, it is not necessary to touch the probe to the components; by simply holding the probe near them, enough energy can be picked up from the stray fields to enable one to judge the quality of the signal at that point.

The probe is constructed of a five-inch length of bakelite or fiber tubing of an inside diameter just large enough to admit a flat-headed metal thumb-tack. Two of these thumb-tacks separated by one-sixteenth inch, make up a minute air-gap condenser in the body of the probe, which very effectually shields the probe tip from the ground capacity of the shielded cable used to transfer the signal to the input of the converter.

To the point of one thumb-tack a one-inch length of stiff piano wire—gauge 20 or 21 is right—is soldered and the other end sharpened. A piece of wooden dowelling, of a diameter just large enough to fit snugly in the tubing, is cut one-half inch long, and a one-thirty-second inch hole is drilled from end to end down the centre The piano wire is pushed through this until the thumb-tack is all the way in, and a turn or two of bare copper wire is wrapped around the free end of the piano wire, flush with the dowel, and soldered to hold the piano wire in place.

The centre wire of a piece of shielded cable about three feet long is pushed through another similar piece of another thumb-tack. The wire is then pulled through until the head of dowelling, and soldered to the pin of the thumb tack is flush with the end of the dowel, and the wire is secured in the same manner as the other.

A very thin coating of speaker cement is then applied to the second piece of dowel and it is pushed through the bakelite tubing until the head of the thumb-tack is just five-eighths of an inch from the other end. A very small hole is drilled through both the tube and the dowel and a small brad nailed through to hold the dowel in place. The other piece of dowel is then pushed into the open end of the tube, thumb-tack first, until the two thumb-tacks are separated by one-sixteenth inch. By pushing it in until the two thumb-tacks touch and then withdrawing it, this distance can be judged quite accurately. A few drops of cement and a brad hold it in place. The shielding on the cable is then brought up about an inch over the other end of the probe and a couple of turns of friction tape wrapped around to hold it in place. A regular phone jack is fastened to the free end of the cable, the inside wire going to the tip and the shielding being connected to the ground side. It is then complete. This is the r.f.-i.f. probe.

Another cable is made up exactly like the first except for the probe, which in this case has a .00025 mf mica condenser set into a slot in the end of another similar bakelite tube and taped fast. The inside wire of the cable is soldered to one terminal of the condenser, and a one-inch length of piano wire is soldered to the other. This is the audio probe.

As to the converter itself, its construction is not difficult. The 6A7 should be well shielded, and the current well filtered; any hum which is introduced into this tube will be very confusing when you're using it to locate hum somewhere else. L and C in the diagram are any ordinary broadcast band r|f. transformer with its primary cut down to about a dozen turns, if it has more than that, and the tuning condenser that goes with it.

The leads to the primary will have to be reversed if the polarity is not correct, for then the tube will not oscillate. Satisfactory evidence of oscillation will be had by removing the grid cap from the 6A7 and, with the dial of the test set turned to about 60 and the volume control turned down low, slowing turning the tuning condenser on the converter. At about the same setting of the converter dial a loud hum should be heard when the finger tip is touched to the control grid of the 6A7. If no such hum is heard and the connections are all right otherwise, reverse the primary leads.

The method of using the instrument is quite simple. When listening in on the r.f. stages the switch on the tuning condenser is closed, rendering the oscillator inoperative. The set under observation is tuned to the strongest local available and the test set tuned to the same station. Either one wire to the voice coil of the set under observation should be unsoldered or a jumper should be put across the voice coil. Then with the r.f.-i.f. test prod the quality of the signal can be ascertained throughout the r.f. stages. If nothing suspicious

is disclosed there, the test set should be tuned to some place on the low-frequency end of the dial where no station whatever can be heard normally, the oscillator switch should be opened, and the oscillator dial set higher than the dial of the test set by an amount equal to the i.f. of the set in question. The test set will then receive the i.f. of this set and, still using the r.f.-i.f. probe, the quality of the signal can be judged up to the grid of the second detector.

Passing to the audio frequency part of the receiver, the audio probe is used and the oscillator dial is set to the same reading as the dial of the test set and the volume of the latter turned down pretty low. The audio frequencies will then modulate the oscillator carrier wave and can be heard through the test set just as if there were being transmitted to it.

Radio Digest

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A survey was made recently to determine just what types of vacuum tubes were being used throughout the radio industry with the thought of possible reduction in the number of types of tubes to be manufactured in the future. The findings of this survey conducted by RCA, were enlightening to say the least.

Out of 453 different tube types on the market to-day, about 90 per cent. of the sales are centered in only 90 tubes and for these 90 types, only 20 basic functions exist. That is, four types of tubes are being used as r-f amplifiers in say a-c receivers, four different types as mixers, four as a-f amplifiers and so on. Furthermore, it was thought that it would be possible to select about 36 basic types of tubes to perform all the functions required in radio receivers to be manufactured. This means, of course, that these 36 types would do the work of the 453 different tubes now being used.

There seems to be little doubt that this reduction in the number of tube types is a step in the right direction and one which will have advantages for all concerned—especially for the radio serviceman. In the first place, it would mean that he would be able to carry a much smaller stock of tubes and still have it complete. To-day it is almost an impossibility for a serviceman to carry a stock that is anyway near complete; generally he can not afford to tie up that much money in his tube inventory and so he stocks just those tubes which move most quickly.

Another advantage to the serviceman would be that he could become more familiar with the different types and their functions. Not only that, but the checking of the tubes in the shop and in the customer's home would be greatly simplified. To-day with the four hundred and some odd tube types it is a real task to check the tubes properly from any receiver. Look at the differences in filament or heater voltages, plate and screen-grid voltages and all the rest—adjustments of knobs and dials have to be made on a tube checker for each one before it can be tested—and all that takes time.

There are, of course, other advantages and also disadvantages, but on the whole it seems as if the standardization of tube types was a step ahead. At this writing nothing throughout the industry as a whole has been decided, but it has been said that RCA receiver engineers in the future will utilize just the 36 basic tube types in their new sets.

Power Output of Receivers.

In looking over the servicing data released by receiver manufacturers, more and more information has been noticed concerning the power output of their receivers at certain input levels. This power output is one of

the significant details associated with receivers and as such, the serviceman should be familiar with it.

A test to establish the power output of a receiver is not as simple as it might appear because of constructional difficulties. However, if two facts are known concerning the voice coil of the loud speaker, then it is possible to establish the power output at whatever signal input levels are specified in the manufacturer's data. In general, the impedance of the voice coil, usually given at 400 cycles, and the equivalent signal voltage across the voice coil are the necessary factors for checking the power output without very much trouble.

The power output may be expressed mathematically as: $W = E \times I$ where W is the power in watts, E, the voltage and I the current. However, it is difficult to insert current-indicating meters into the voice-coil system and since the impedance of the coil is generally given by the manufacturer, the power output can be more readily identified by establishing the voltage in accordance with the following equation: $E = \sqrt{R \times W}$ where R is the impedance of the voice-coil winding and W is the power output as given in the service manuals.

For example, if the voice-coil impedance, R, is 5 ohms and the power output W, is 0.05 watt (50 milliwatts) then the signal voltage, E, measured across the voice coil will be found to equal $E = \sqrt{5 \times .05}$.

In practice it has been found that the voice-coil impedance in the majority of receivers is 5 ohms or less. In some few cases, voice-coil impedances have been found up to as great as 15 ohms, but such values are not commonplace; on the contrary, a great many receivers have speakers with 3.5 ohm voice-coil impedances. Naturally, when calculating the value of E mentioned above, the exact value of R must be used, but these generalities have been given as it was felt that they would prove of value.

In the following table will be found a series of values of signal voltages and voice-coil impedances that are equivalent to a power output of 0.5 watt. This value of power output was chosen as a basis for these calculations inasmuch as the power output of many receivers on the market to-day are based on this figure.

Voice Coil Imped. ohms	Signal Voltage volt	Voice Coil Imped. ohms	Signal Voltage volt
.2	.33	2.0	1.0
.4	.446	2.25	1.06
.5	.5	2.50	1.12
.6	.547	2.75	1.17
.75	.61	3.0	1.22
.8	.632	3.25	1.27
1.0	.707	3.5	1.32
1.2	.774	3.75	1.36
1.4	.835	4.0	1.404
1.5	.864	4.5	1.49
1.75	.934	5.0	1.58

The fact that these figures for the voltages have been carried out to three places does not mean that this high order of accuracy is necessary. The vacuum tube voltmeter that the serviceman usually employs in his work wil lbe found to be entirely satisfactory. The calculations in the above table were made with a slide rule and the nearest approximations are given, so that if a man works to the nearest tenth, he will obtain results that will suffice to all intents and purposes.

Divisonal Notes

IMPORTANT.

To ensure insertion all copy must be in the hands of the Editor not later than the 18th of the month preceeding publication.

VK4 NOTES by 4ZU.

4RY—Bill just been appointed vice-president of this division. He hasn't told us whether he is pleased about it or not. Is also in the local A.R.P. Organisation.

4JF—Jack, one of our most regular attenders. Believe it or not, he still gets a card occasionally.

4LT—Albert is in camp; beyond that it is a case of know nothing, see nothing, hear nothing. Don't forget that you're supposed to write these notes Orm.!

4WT—Bill, rather an active man these days. He is one of the committee appointed to organise the listening scheme which we are getting under way. Made a very nice job of a frequency meter.

4HR—Tibby, along with John 4RT, have developed a habit of sinking down into the rather comfortable chairs in the room where we hold general meetings. All one can see of either of them is the top of their heads behind a book.

4AW—Still punching a key out at Archerfield for the R.A.A.F.

4SN—Visitor from the country down in VIB for the show. Frank says he has all the room he wants for beams now. Just too bad, isn't it Om.?

4ES—What's up Herb.? Haven't seen you the last couple of meetings.

4UU—Bill still holds the purse strings for us. He is pretty good at it too. I suppose it comes of long practice Bill?

4OK—Jack is another R.A.A.F. man. Spends most of his time in the radio hut at Archerfield.

4LS—Les, up in Toogoowalah, has made an appearance, and we wish you all the best. Om.

4AH—Teaches morse to Air Force men. Now you now why R.A.A.F. men are good ops.

4KH—Haven't had any news from you for a while, Om. What say?

ELIMINATING DOUBLE CALLS.

Elimination of double call letter designation of American broadcasting stations—plentiful in the early days of radio, but now only a few remain—is being tackled by the Federal Communications Commission.

To prevent confusion and in the interest of simplification, the FCC has asked WIOD-WMBF, Miami, and WSYR-WSYU, Syracuse, to dispense with half of their combinations, allowing them to make a choice. Double call-letters have resulted from previous station amalgamations. The only other double combination is WABC-WBOQ, N. York. Such stations as WOOD-WASH, Grand Rapids, who use the same transmitter, but hold separate licences for half-time are not affected.

Postponement of "Broadcasting Day" from July 4 to August, so that both New York and San Francisco World's Fairs will be able to collaborate in the event, has been decided upon by principals of the radio industry and the Fair Organisation.

Originally the event was planned for the New York Fair of Independence Day at which a plaque symbolic of radio was to be dedicated.

Under the revised plans, the ceremony will be held on either August 3 or 7. Separate plaques will be unveiled at New York and San Francisco. It is believed likely that President Roosevelt will take part in the ceremony.

Ham Chatter

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THIS MONTH'S BEDTIME STORY.

(From "Radio News," June, 1940)

In the 7th District lived two hams. Unusual, too was the fact that they were husband and wife. Both had calls, and both used their tiny rigs for whatever pleasure you can get for operating with a tenth watt in the crowded 7mc. band. As receivers they had a one tube regenerative set each. One trouble developed and that was that each could pick up the other's receiver far better than they could any sigs. Also, in case I forgot to mention it, they were so poor, that the mice in the kitchen were moving back to the Church, and the Cockroaches were bringing in their own lunch.

When Christmas approached the OM thought things over, and decided that there would not be anything quite so nice, quite so welcome to the XYL, as a fb receiver. He had one all spotted, second-hand, at the local hamstore where they held a "blind" auction every week end. You were assigned a number and then you wrote your number and the amount you offered for the set on a card on the wall, and other hams who wanted to bid against you wrote their numbers and the amount higher than your bid which they wished to pay for the set. Our Hero started at $5 which he expected to get as a present from the Simon Legree who employed him as dish-washer in the local hamslingery. The next day he went to the hamstore again during his lunch hour.

Sure enough, another couple of hams had raised the price to $8. Our hero added his number and wrote down $8.50. The next day there were only two other hams left in the auction and our Hero had to go to $9.75 to top them. The next day only one other ham was left and our Hero reluctantly placed his bid in at $10. The other ham raised to $10.50; our Hero raised back to $10.75. The other ham raised to $11; and our Hero raised it to $12 to freeze out the other guy. He got the receiver. He snuk it home. "What a present for the XYL," he thought.

Christmas morning dawned clear, cold and cheerful. On the bare table reposed the heavy package which represented all our Hero's money, his lunches for the next two weeks, and an advance from the Boss.

His XYL opened the package, her face lighted up, then her chin trembled.

"Why, Harry," she cried, "You got this from the ZYX Hamstore, didn't you?"

"Yes, dear," Harry replied, "And I would have gotten it lots cheaper except I had to bid against a guy whose number was 65789 and he kept raising me."

The XYL went to the cupboard, took there from her purse and handed the OM a card without a word. It read:

"Dear Mrs Blank:

We have entered you in our weekly blind auction, for the Blahblah FXB-76T Receiver; and you have been assigned number 65789.

Very truly yours,
THE ZYX HAMSTORE."

H. HEARNE & CO. PTY. LTD., 285-7 LATROBE STREET, MELBOURNE, C.1.